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Principal Real Estate

Principal Asset Management℠

Evolving data center sustainability and the role of the capital partner

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AT-A-GLANCE

- Customer requirements, business value, government regulations, and community sentiment are among the top drivers of data center providers' investments in environmental sustainability.
- The approach to sustainability has evolved over the years—from a focus on energy efficiency, then water efficiency, to greenhouse gas (GHG) emissions, waste, and local ecosystem impact.
- Sustainability is a joint effort between data center providers, their customers, and their capital partner. At Principal, we work closely with our data center providers to reduce the environmental impact of their operations.

Sustainability is a key priority for most companies as they seek to mitigate climate change, manage risk, meet customer expectations, and attract investors. Increasingly, companies are looking beyond their own operations to their providers' sustainability practices. In the data center industry, the largest customers have made aggressive climate pledges and providers are implementing a range of sustainability measures. In this paper, we explore the benefits data center providers realize from sustainability initiatives, how their approach to sustainability has evolved, and the role of the capital partner.

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Why data center sustainability matters

Improving the environmental sustainability of data centers is essential for the health of the planet. It's also good business. As one of the data center providers we work with puts it, "Sustainability is existential." Customer requirements, business value, government regulations, and community sentiment are among the top drivers of data center providers' investments in environmental sustainability.

Customer requirements

For most data center providers, the majority of revenue comes from a relatively small number of very large technology companies (hyperscalers) and Fortune 100 enterprises. These customers have all made significant commitments to reducing their environmental impact—for example, climate pledges in line with the Paris Climate Agreement and pledging to achieve net zero greenhouse gas emissions by 2050 or earlier.

These customers often have specific sustainability requirements for their data center providers. In fact, 80% of respondents to a Forrester survey of 1,033 global sustainability decision-makers at colocation providers say they see specifics on environmental sustainability during the bid/RFP/sales process with clients.[1] Accordingly, 83% of data center providers responding to the Forrester survey use sustainability as a way to attract new business, and 75% say they have lost business and/or investments due to not having sustainability programs in place.

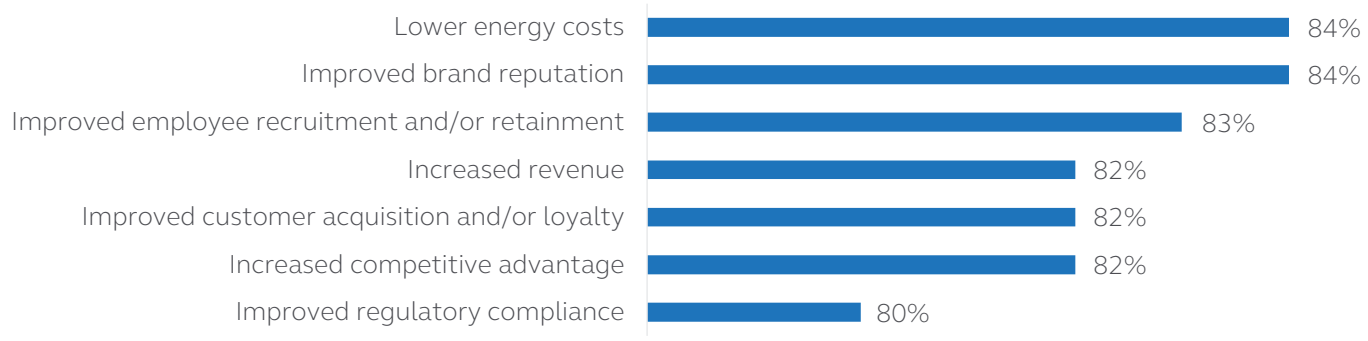
Business value

Data center providers can realize significant business value from their investments in sustainability. For one, sustainability practices can improve a provider's competitiveness. In most cases, utility costs are passed directly to the customer, so when a data center provider reduces the use of natural resources (i.e., energy and water) it's good for the planet and helps reduce costs for the customer—two benefits that boost the provider's competitive advantage. Furthermore, investments in sustainability are often investments in innovations that customers are seeking; direct liquid cooling is a good example.

Permitting is another way sustainability practices deliver business value for data center providers. In a growing number of data center markets, power and land constraints have made it more difficult to secure the permits necessary for development. In some markets, community pushback against data center development has further stymied the permitting process. Data center providers that are positioned well to respond to community sustainability concerns often have an easier time getting permitting approved for development.

Finally, sustainability practices have proven to help data center providers retain talented employees—a significant benefit given the industry's perennial talent crunch.

EXHIBIT 1: Business benefits of sustainability initiatives



Source: A commissioned study conducted by Forrester Consulting on behalf of Schneider Electric in April 2022. 1,033 global sustainability decision-makers at colocation providers responded to the survey.

[1] Source: A commissioned study conducted by Forrester Consulting on behalf of Schneider Electric, April 2022.

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Government regulations

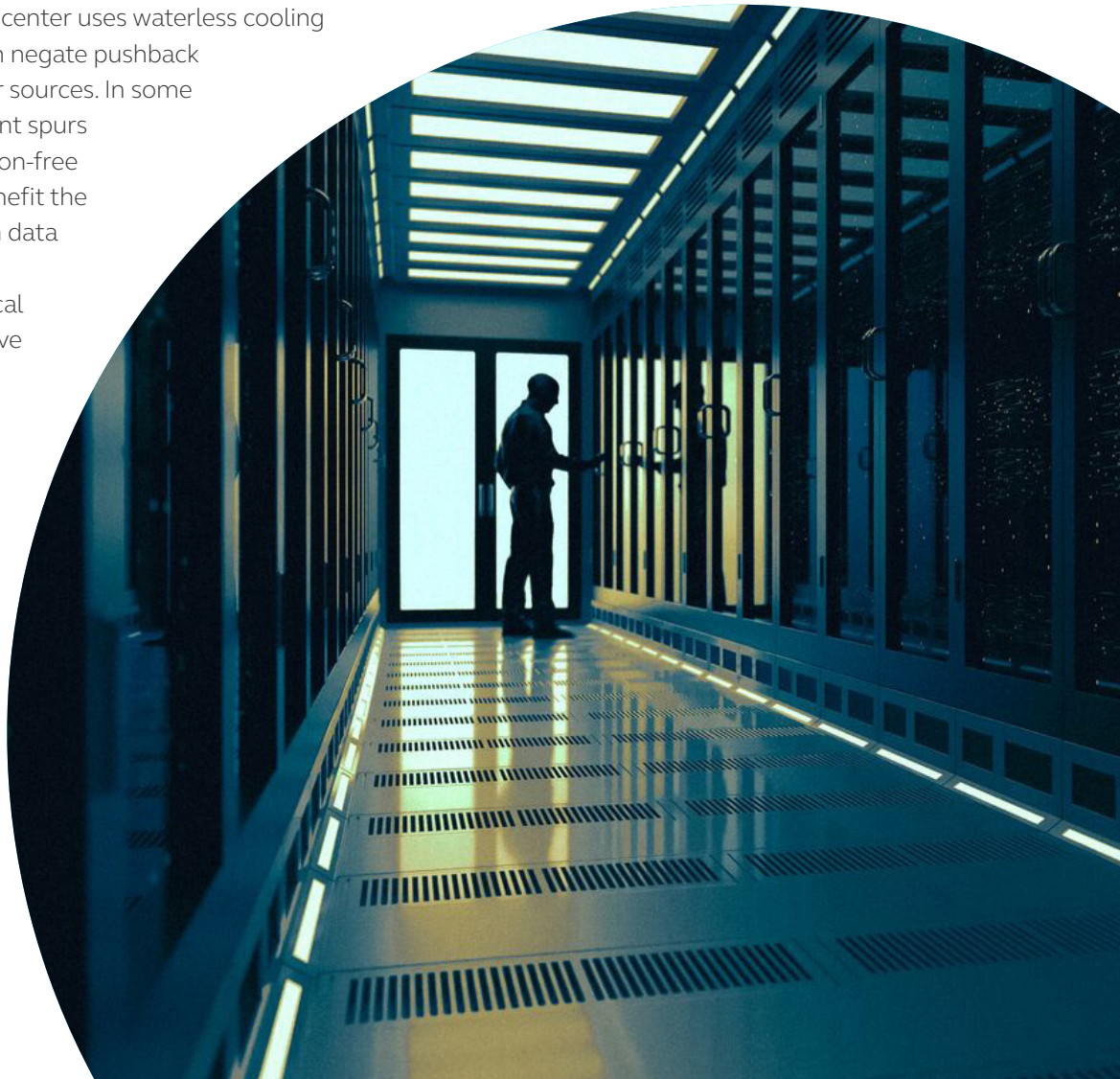
The U.S. and Europe have quite different approaches to regulating data center sustainability, with European laws tending to be far more proscriptive and regulators in the U.S. tending to defer to voluntary programs. The European Green Deal released in January 2021 introduced controls on business, including data centers. Mandatory regulations come primarily from the Energy Efficiency Directive (EED) and Corporate Sustainability Reporting Directive (CSRD).

There is no similarly overarching federal regulation in the U.S., although the Office of Technology and Science Policy is developing evidence-based environmental performance standards to mitigate growth in data center energy consumption. At the state level, California has passed laws that are similar to CSRD in the EU. California's new climate disclosure laws, the Climate Corporate Data Accountability Act (SB 253) and the Climate-Related Financial Risk Act (SB 261), require large businesses to report their greenhouse gas emissions and climate-related risks. The laws are collectively known as the Climate Accountability Package.

Community sentiment

In some communities, negative public perception has impeded data center development. As we wrote in 10 trends driving the global data center market, "Concerns about data centers' impact on local resources and quality of life have led to tensions between developers and residents and officials. Fears about noise, water usage, and strains on the power grid are causing some communities to view data centers as more of a burden than a benefit."

"Addressing public concerns and building trust will be essential for the long-term success of the data center industry," and sustainability practices can help. If the data center uses waterless cooling systems, for example, that can negate pushback about the drain on local water sources. In some cases, data center development spurs the development of new carbon-free energy sources, which can benefit the community as well. And when data center providers take steps to reduce their impact on the local ecosystem, it can breed positive community sentiment.



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How data center sustainability practices have evolved

The practices data centers implement to minimize their environmental impact have evolved over the years. Initially, the focus was primarily on energy efficiency, then water efficiency. Now, greenhouse gas (GHG) emissions reductions are a top focus, as is waste reduction and mitigating the impact of the data center on the local ecosystem.

Energy efficiency

The first metric of data center efficiency accepted across the industry was power usage effectiveness (PUE), released by The Green Grid in 2007. PUE is the ratio of the energy used by the IT equipment to the total amount of energy used in the data center. A PUE of 2.0 means for every watt of IT power, the data center consumes an additional watt to cool and distribute power to the IT equipment. A PUE of 1.0 (a practical impossibility) means the facility uses no power except for IT.

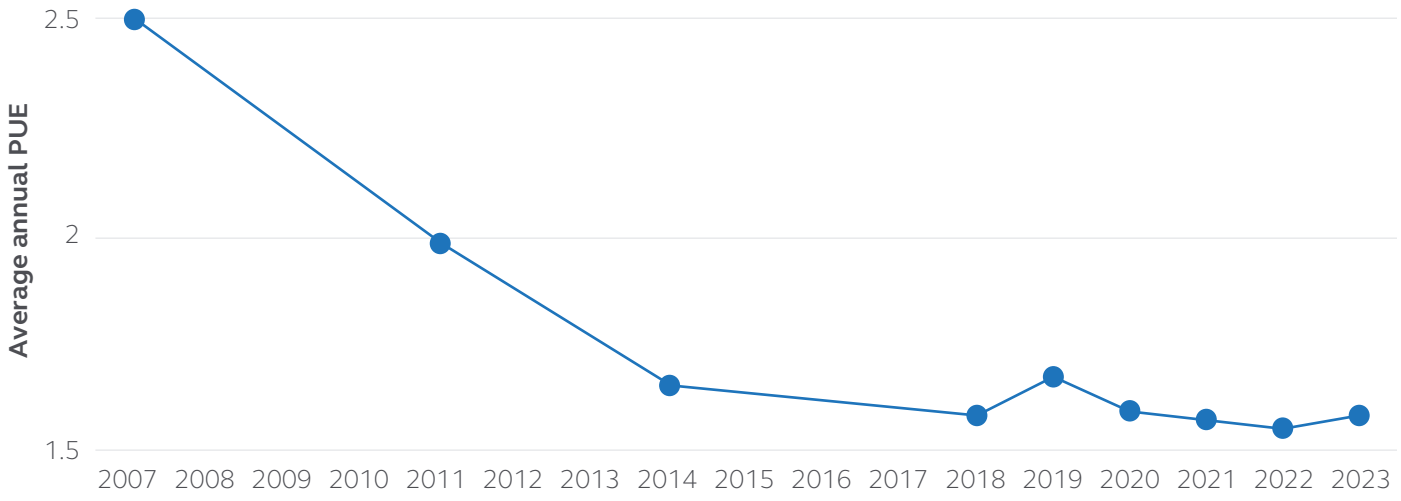
Data center providers can reduce PUE through practices that include:

1. **Airflow management;** most data centers use hot aisle/cold aisle containment to minimize the mixing of hot and cold air
2. **Raising the cold aisle temperature**
3. **Free cooling,** which is heat removal without the use of chillers (the dominant energy-using component of the cooling infrastructure)
4. **Optimizing power distribution**

Across the industry, PUE has improved significantly over the years (see Exhibit 2). Gains stalled in recent years largely because the closer a data center gets to a PUE of 1.0 the harder it becomes (in terms of technology available and cost) to achieve further reductions. The data in Exhibit 2 represent the average annual PUE reported by 567 respondents to the Uptime Institute's annual data center survey, encompassing a wide range of facility ages, sizes, and climates. Hyperscalers operating the world's largest data centers frequently report PUEs of 1.2 or even lower.

Some governments are starting to regulate PUE. For example, in Germany the Energy Efficiency Act makes PUE targets obligatory for data centers, depending on when they were put into operation. Data centers that began operations before July 1, 2026 must comply with a PUE of 1.5 from July 2027 and 1.3 from July 2030. Data centers that begin operations after July 1, 2026 must have a PUE of 1.2

EXHIBIT 2: Industry average PUE has improved significantly since 2007, though gains stalled in recent years



Source: Uptime Institute Global Data Center Survey 2023

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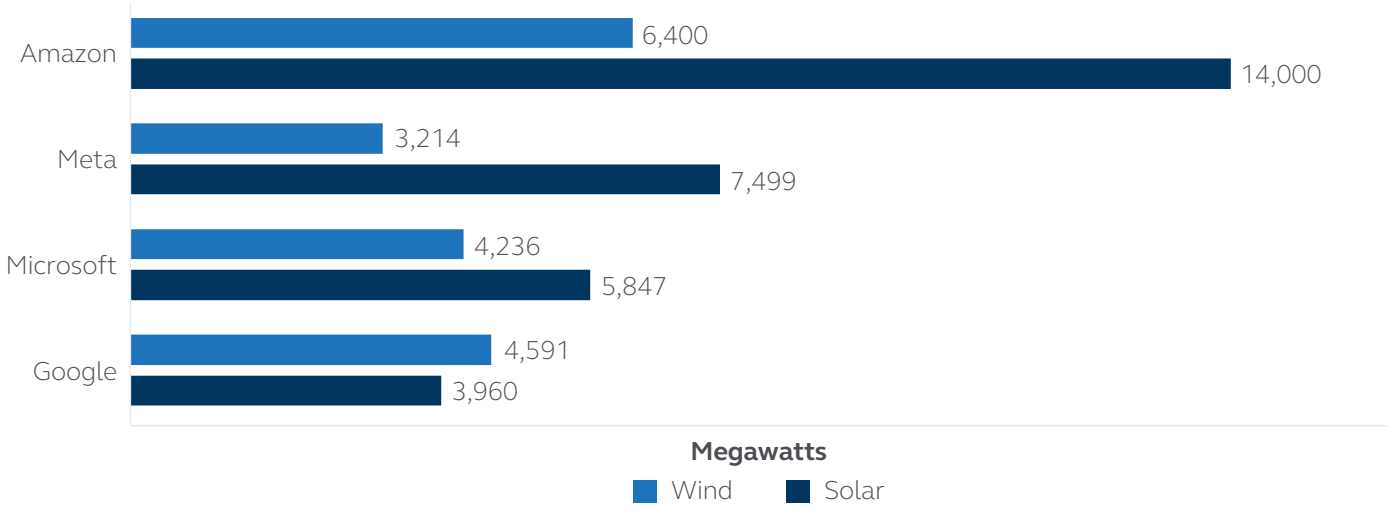
Energy sources

For many years now, data center providers have sought to reduce their reliance on fossil fuels and use green energy to power their facilities. There is a variety of mechanisms for procuring green power; most rely on renewable energy certificates (RECs). For every megawatt-hour of renewable electricity generated by a power supplier, a REC is created. Current GHG protocol guidance requires RECs to be used to reduce scope 2 emissions outside of grid decarbonization mechanisms.

An increasingly common method for directly procuring renewable energy is the Power Purchase Agreement (PPA). A PPA is a contract between an energy consumer and a renewable energy supplier; the supplier gets a fixed price per megawatt-hour of energy and the consumer gets the associated RECs. Hyperscalers are the top corporate off-takers of renewable energy PPAs (see Exhibit 3).

Leading data center providers have in-house energy brokerage teams that work with customers to support their carbon-free capacity goals. For carbon-free electricity for IT and mechanical loads, hyperscale customers can often purchase energy from newly-built renewable generation sources—improving the overall carbon-footprint of the generation fleet in geographies where the data centers are located. Beyond renewables like solar and wind, there is an increasing focus on carbon-free energy sources such as hydroelectric and nuclear power.

EXHIBIT 3: Between 2010 and 2022, hyperscalers were the top corporate off-takers of renewable energy PPAs



Source: International Energy Agency (IEA)

To date, vastly more green power sales have come in the form of unbundled RECs than any other mechanism. Unbundled RECs are a stand-alone product, "unbundled" from the organization's electricity purchases. These types of purchases are increasingly controversial, as they're widely seen as mechanisms for companies to only appear as if they use little to no fossil fuels.

Data center providers can also generate their own renewable energy, either on-site at the data center or off-site. Beyond the sustainability benefits, on-site self-generation also reduces the facility's dependence on the utility power grid.

There are challenges to on-site renewables. Most significantly, the low power density of renewables means a very large area is needed to generate meaningful amounts of power; few data center developments have enough space to put solar on-site to cover more than 1-3% of the building energy use. Another challenge is the intermittency of solar and wind, although advancements in energy storage space and grid management are helping to overcome that challenge.

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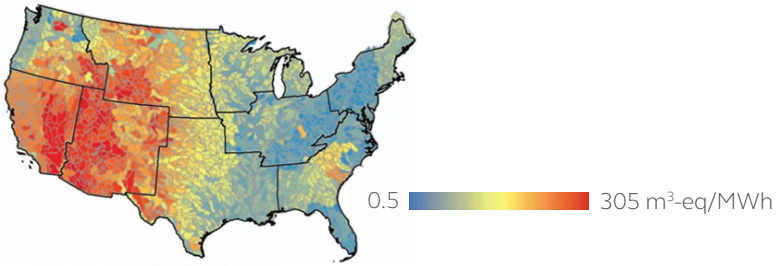
Water efficiency

The Green Grid released a metric for measuring water efficiency in 2011, but it was more recently that data center operators began focusing on water usage—as concerns about water resource constraints have grown in many markets. Water usage effectiveness (WUE) measures how much water a data center uses in relation to its energy consumption. As with PUE, a lower WUE reflects more efficient water usage.

As much as 20% of data centers in the United States draw from watersheds that are already "moderately or highly" water-stressed, according to 2021 research from Virginia Tech and Lawrence Berkeley National Lab.[2] The Uptime Institute cites California, Singapore, Spain, the United Arab Emirates, and Australia as cautionary examples of places where massive demand from data centers is stressing local water supplies—and governments are pushing back. In Phoenix, some local policymakers have denied new data center permits because of water use concerns.

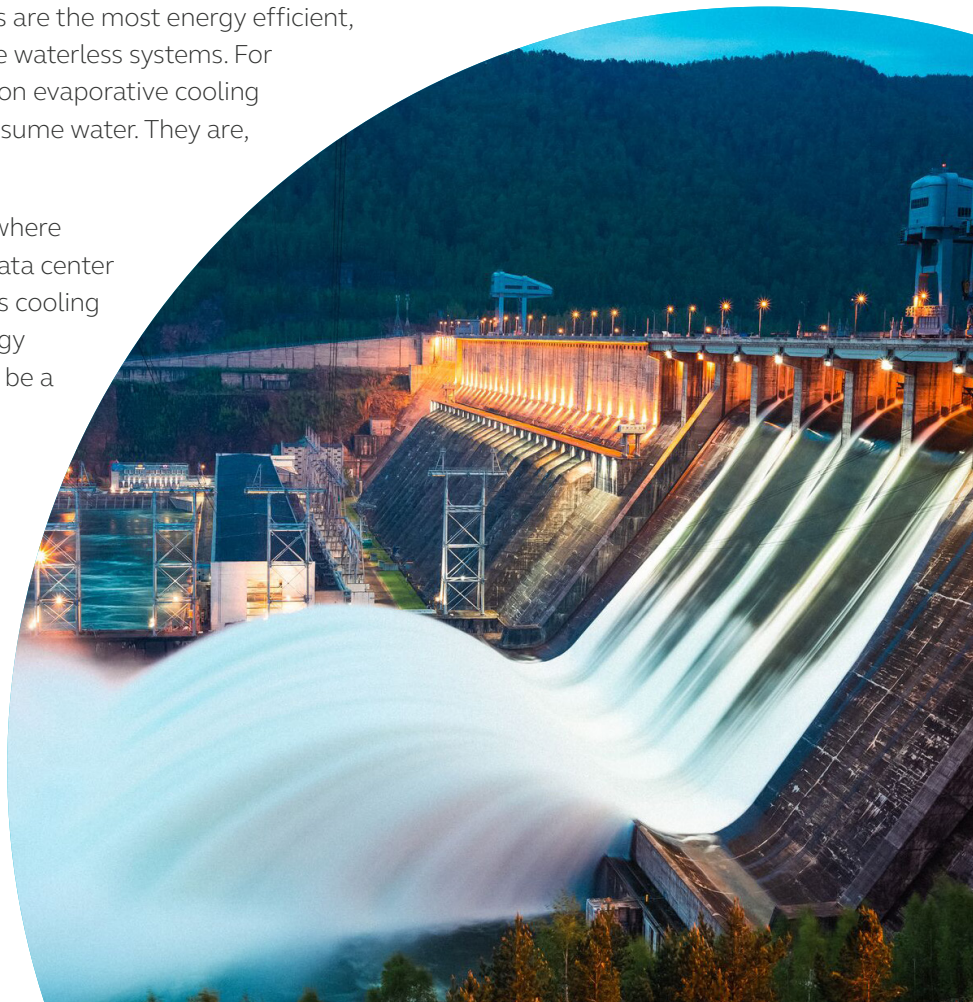
EXHIBIT 4: A data center's water scarcity footprint is highly contingent on where it is located



Source: Md Abu Bakar Siddik et al, The environmental footprint of data centers in the United States, 2021
Note: The heatmap depicts the water scarcity intensity (measured as water consumption per unit of energy consumption) of a hypothetical 1 MW data center placed in each of the 2110 subbasins of the continental United States.

In traditional data center designs, the main consumers of water are cooling towers, used to reject the heat created by the IT equipment.[3] All else equal, these water-based evaporative cooling systems are the most energy efficient, and also water intensive. Alternatively, there are waterless systems. For example, air-cooled chiller systems do not rely on evaporative cooling towers and, as closed-loop systems, do not consume water. They are, however, more energy intensive.

In water-constrained markets and/or markets where renewable energy is readily available, leading data center developers are increasingly relying on waterless cooling systems. Where water is abundant and/or energy sources are particularly "dirty", using water can be a valuable tool to reduce emissions.



[2] Md Abu Bakar Siddik et al, The environmental footprint of data centers in the United States, 2021.

[3] There are broadly two parts of a data center cooling system: the first takes the heat away from the servers, the second rejects the heat to the outside. Here, we are talking about rejecting the heat to the outside, which can be done with evaporative cooling systems (which use a lot of water) or air-cooled chiller systems (which don't use water).

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Greenhouse gas emissions

As the practices data centers implement to minimize their environmental impact have evolved over the years, greenhouse gas emissions reductions, waste reduction, and mitigating the impact of the data center on the local ecosystem have become significant areas of focus.

Accomplishing the goal of reducing GHG emissions requires a nuanced view of emissions across the data center lifecycle. A complete accounting of the data center's environmental impact includes both location-based and market-based Scope 2 emissions as well as Scope 3 emissions.

- **Scope 1** emissions are those the data center is directly responsible for, such as emissions produced by backup generators.
- **Scope 2** encompasses a data center's indirect GHG emissions, such as those created in the production of electricity used by the data center.
- **Scope 3** emissions are the result of activities from assets not owned or controlled by the data center, but that the data center indirectly affects in its value chain, such as the emissions generated in the production and transport of mechanical, electrical, and plumbing (MEP) gear. Scope 3 reveals how much carbon is embedded in all facets of the facility—from batteries in the uninterruptible power supply (UPS) to concrete and steel in the building.

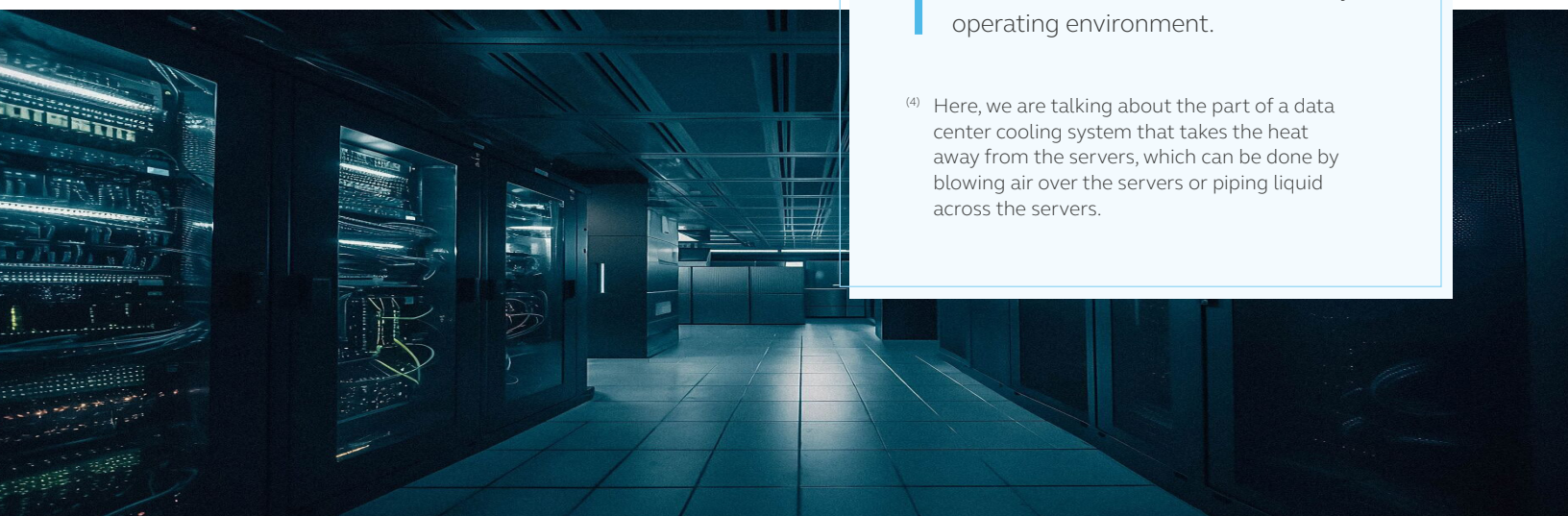
Some companies purchase carbon offsets, which allow them to offset the carbon they emit through their operations by funding green initiatives elsewhere. As with RECs, carbon offsets face increasing criticism for giving companies an "easy" alternative to actually reducing their carbon impact.

Cooling system innovation to reduce GHG emissions

Next to IT loads, mechanical systems are a leading source of emissions. Redesigning their cooling system to support the next generation of workloads, Stream Data Centers (one of the data center providers Principal works with) also boosted efficiency and reduced emissions. In this excerpt adapted from the whitepaper Liquid Cooling is More Sustainable, Stream's Vice President of Product Innovation and Sustainability explains how:

> Today, air as the fundamental cooling medium is still the most common means to take heat out of a data center.[4] Yet at some point in the not-distant future, heat fluxes for the most powerful processors will be too high to manage with direct air cooling. When it comes to heat transfer, liquids are fundamentally more efficient than air.
>
> There's a significant added benefit as well: liquid cooling is much more sustainable. It has the potential to reduce Scope 2 and Scope 3 emissions substantially by reducing the amount of energy and MEP infrastructure required, increasing opportunities for economization, CPU efficiency, and even waste heat use. It also makes the data hall a more human-friendly operating environment.

[4] Here, we are talking about the part of a data center cooling system that takes the heat away from the servers, which can be done by blowing air over the servers or piping liquid across the servers.



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Waste

"Minimizing waste from the supply chain and diverting it out of landfills through reuse and recycling is a key strategy for environmental sustainability."[5] Leading data center providers have set goals to achieve zero waste to landfill where possible—with some targeting at least a 90% total waste diversion rate.

Local ecosystem

Data centers have direct and indirect impacts on the local ecosystem. As with water and energy, data centers' impact on local ecosystems has, in some markets, been an impediment to development. On the other hand, data center providers implementing sustainability practices that reduce impact to the local ecosystem can realize the benefits of positive community sentiment.

Leading data center providers conduct thorough location feasibility analyses to understand the risks to the site under today's conditions and for future conditions. For example, at one of the data center providers Principal works with, the dedicated location strategy and development team leverages a proprietary platform to analyze and display pertinent information about potential sites—including information about land use, species abundance, etc. that will determine the data center's impact on the local ecosystem. This rigorous analytical approach enables the data center provider to mitigate the impact of development on the local ecosystem.[6]

The role of the capital partner

Sustainability is a joint effort between data center providers, their customers, and their capital partners. It is the provider's sustainability practices that ultimately affect customers, but the capital partner often influences those practices. At Principal, we work closely with our data center providers to minimize environmental impact of operations, mitigate climate risk, and promote social responsibility. Our Sustainability Policy and Sustainability Guidelines for Data Centers form the foundation of our commitment to sustainability and outlines our expectations for integration of sustainability strategies into our investment management practices for our data center providers.

Principal Real Estate sustainability policy

Principal Real Estate has a long-standing commitment to corporate stewardship and an established track record in responsible property investing, starting with the first iteration of our sustainable investing framework in 2008. Since then, the framework has been expanded and enhanced to encompass environmental, social, governance (ESG), and resilience factors, becoming the Pillars of Responsible Property Investing (PRPI) sustainable investing platform. This platform guides our investment management practices and our internal teams, third-party joint venture partners, and property management companies.

Through our commitment to responsible property investing and strong governance practices, we seek to invest in real estate that delivers positive financial and sustainability outcomes for all stakeholders while promoting health and wellbeing for our tenants and residents, minimizing our environmental impacts, and enhancing the communities where we operate. Consistent with this commitment and our role as investment managers, we will enact and implement sustainability practices in three categories: Environmental Stewardship, Social Responsibility, and Governance Oversight.

The Sustainability Policy formalizes our commitment to responsible property investing by embedding sustainability throughout the real estate investment, lending, management, and operations processes. We developed Sustainability Guidelines, including for data centers, which directly support the implementation of the Sustainability Policy, and further detail tactical actions required of Principal Real Estate staff and third-party property managers, service providers, and joint venture partners.

Principal sustainability guidelines for data centers

Principal Real Estate recognizes the growing importance of real estate, infrastructure, and technologies that support the digital economy. Specifically, data centers and colocation facilities play an increasing role as the foundation for business, social, and economic networks. Data centers and real estate associated with information technologies have many unique development, operations, maintenance, security, and energy requirements. Emerging sustainability strategies may not always apply or be feasible given these circumstances.

[5] Paul Lin et al, Guide to Environmental Sustainability Metrics for Data Centers, 2023.
[6] Stream Data Centers, Hyperscale Site Selection Executive Brief, 2023.

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The guidelines detailed are intended to supplement the Principal Real Estate Sustainability Policy. They outline practices to successfully navigate this unique real estate asset class from a sustainability perspective—bringing enhanced value and reduced risks—and depend on strong collaboration and aligned objectives between data center providers, customers and capital partners. Thinking this aligns better with how we defined the stakeholders previously.

Consistent with the evolution of sustainability strategies and best practices, our fiduciary responsibilities, and our goal to enhance value for all stakeholders, we will seek to collaborate with appropriate parties as part of our data center investments on the following:

1. **Meter and share** energy consumption and environmental performance data as mutually agreed through the lease activities, enabling both parties to monitor consumption and costs, and disclose performance metrics as part of sustainability reporting frameworks.
2. **Collaborate** with data center customers (tenants) and building occupants to identify opportunities to reduce energy consumption and costs while maintaining operational standards and building comfort.
3. **Participate** in industry working groups and organizations promoting high-performance and environmentally responsible data center operations, such as the Northern Virginia Technology Council (NVTC), the Data Center Coalition, or the European Data Center Association (EDCA), as appropriate.
4. **Assess** property exposure to physical and transitional climate risks and implement appropriate mitigation plans.
5. **Pursue** recognized sustainable building certifications where consistent with the investment strategy.
6. **Support** data center customers' (tenants') sustainability initiatives and participation in voluntary frameworks, such as the Future of Internet Power Initiative, CDP, the Renewable Energy Buyers Alliance, and United Nations Sustainable Development Goals, or other programs.
7. **Negotiate** and secure clean and renewable energy contracts where available and when in alignment with data center customers' (tenants') energy cost and procurement objectives.
8. **Provide** technical expertise and support for issues affecting building operations, maintenance, equipment, backup power, alternative power sources, on-site renewables, emerging technologies, or other areas as requested by clients.
9. **Educate and inform** data center customers (tenants) and local community leaders of emerging sustainability practices and standards that are material to the success of the property.

As partnership opportunities, new technologies, and industry practices emerge and evolve, Principal Real Estate will continue to collaborate with our data center stakeholders to promote and implement sustainability initiatives, and revise and update these best practices accordingly. Learn more at principal.com/sustainability/esg-data-center.

Bottom line

Whether data center providers are implementing sustainability practices because their customers demand it, to gain competitive advantage, to comply with government regulations, to improve community sentiment and smooth the development process—or, most likely, for all of those reasons—sustainability benefits the environment and is good for business.

Data center sustainability practices continue to evolve, and yesterday's stretch goal may be today's table stakes. Forward-thinking data center providers continue to innovate new ways to mitigate their impact. As a capital partner, we believe we have a responsibility to focus investments into these kinds of providers, and to support them as they fulfill their essential role as the cornerstones of the modern global economy—sustainably.

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Appendix: Evolving data center sustainability metrics

As sustainability practices have evolved, so have the metrics used to measure their efficacy. Early metrics like power usage effectiveness (PUE) and water usage effectiveness (WUE) did help drive efficiencies. But because they are self-reported and don't account for the local climate, these metrics are not ideal for rigorous benchmarking and alignment between providers or even from one facility to another.

Today, "Data center operators are facing mounting pressure from investors, regulators, shareholders, customers, and employees to provide greater transparency on the reporting of their data center's environmental impact."[7] To that end, Paul Lin, Robert Bunger, and Victor Avelar at Schneider Electric created a framework with 28 standardized metrics for reporting environmental impact across the data center's lifecycle.

Energy

Today, the vast majority of data center providers have implemented energy efficiency practices to lower PUE. But as it only covers mechanical and electrical efficiency, PUE was never intended to be a broad measure of carbon impact, much less a holistic measure of sustainability. For a more holistic measure of energy sustainability, Lin, Bunger, and Avelar recommend six metrics:

- Total energy consumption
- Power usage effectiveness (PUE)
- Total renewable energy consumption
- Renewable energy factor
- Energy reuse factor
- Server utilization

Water

As with PUE, WUE doesn't account for the local climate, and therefore isn't ideal for rigorous benchmarking and alignment between providers or even from one facility to another. For a more holistic and comparable measure of water sustainability, Lin, Bunger, and Avelar recommend five metrics:

- Total site water usage
- Total source energy water usage
- Water usage effectiveness (WUE)
- Water replenishment
- Total water use in supply chain

GHG emissions

In 2010, The Green Grid proposed a metric to assess a data center's emissions relative to its energy usage. Carbon usage effectiveness (CUE) measures a data center's total emissions resulting from the total energy used at the facility, relative to the energy consumed by IT equipment. Like PUE and WUE before it, CUE was useful for giving data center operators a way to think about their emissions—but not ideal for rigorous benchmarking and alignment between providers or even from one facility to another.

For a holistic and comparable measure of GHG emissions, Lin, Bunger, and Avelar recommend seven metrics:

- Scope 1 GHG emissions
- Scope 2 GHG emissions (location-based)
- Scope 2 GHG emissions (market-based)
- Scope 3 GHG emissions
- Carbon usage effectiveness (CUE)
- Total carbon offsets
- Hourly renewable supply and consumption matching

[7] Paul Lin et al, Guide to Environmental Sustainability Metrics for Data Centers, 2023.

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Waste

"Data centers are challenged with a unique waste profile compared to other industrial operations. In order to meet circularity goals/targets, data center operators need to understand their waste profile (especially E-waste and batteries) with tailored data center metrics. Minimizing waste from the supply chain and diverting it out of landfills through reuse and recycling is a key strategy for environmental sustainability. Circular economy design methodologies and processes support improvements in this area."[8]

Lin, Bunger, and Avelar recommend six metrics:

- Total waste generated
- E-waste generated
- Battery waste generated
- Total waste diversion rate
- E-waste diversion rate
- Battery waste diversion rate

Local ecosystem

"Data centers have direct and indirect impact on the local ecosystem (i.e., biodiversity) including land, sound level, species, etc. For example, data centers have a direct impact on the land they are built upon and an indirect land impact from their supply chain. Measuring the impacts to land are common in industries like mining but are new to the data center industry. The HVAC equipment (e.g., cooling towers, dry coolers, ducts) and diesel gensets in a data center can produce high levels of noise, which draw attention from local jurisdictions. Greenfield data center construction also impacts the quantity and diversity of species around it."[8]

Lin, Bunger, and Avelar recommend four metrics:

- Total land use
- Land use intensity
- Outdoor noise
- Mean species abundance

[8] Paul Lin et al, Guide to Environmental Sustainability Metrics for Data Centers, 2023.

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